Mar 2024

SemiHow
Know-How for Semiconductor

HIA40N120T-SA

1200V N-Channel Trench Field Stop IGBT

Features

- Very Low $V_{CE(sat)}$
- Extremely low switching loss
- Excellent stability and uniformity
- Soft Fast Reverse Recovery Diode
- Short Circuit Withstand Time 10.0μs
- Maximum Junction temperature, $T_{J(max)}$=175℃

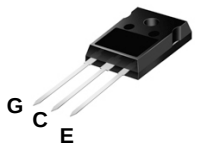
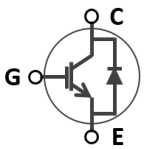
Application

- Motor drivers
- Uninterruptible Power Supplies (UPS)
- Solar / Welding converters
- High frequency Converters

Key Parameters

Parameter	Value	Unit
V_{CES}	1200	V
I_C	40	A
$V_{CE(sat)}$	1.45	V
E_{tot}	3.87	mJ

Package & Internal Circuit

TO-247	SYMBOL
	

Absolute Maximum Ratings

T_C=25℃ unless otherwise specified

Symbol	Parameter		Value	Unit
V_{CES}	Collector-Emitter Voltage		1200	V
V_{GE}	Gate-Emitter Voltage		±25	V
I_C	Collector Current	(@ T_C = 25 ℃)	80	A
		(@ T_C = 100 ℃)	40	A
I_{CM}	Pulsed Collector Current (Note. 1)		160	A
I_F	Diode Continuous Forward Current (@ T_C = 100 ℃)		40	A
I_{FM}	Diode Maximum Forward Current		160	A
P_D	Power Dissipation	(@ T_C = 25 ℃)	428	W
		(@ T_C = 100 ℃)	215	W
T_J	Maximum Operating Junction Temperature		175	℃
T_{STG}	Storage Temperature Range		-55 to +175	℃

Thermal Resistance Characteristics

Symbol	Parameter	Value	Unit
$R_{\theta JC}$	IGBT Thermal Resistance, Junction-to-Case, Max.	0.35	℃/W
$R_{\theta JC}$	Diode Thermal Resistance, Junction-to-Case, Max.	0.78	℃/W
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient , Max.	40	℃/W

Notes : 1. Repetitive Rating, Pulse width limited by maximum junction temperature

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Electrical Characteristics T_J=25°C unless otherwise specified

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
Static Characteristics						
BV_{CES}	Collector-Emitter Breakdown Voltage	V_{GE} = 0 V, I_C = 250 μA	1200	-	-	V
I_{CES}	Zero Gate Voltage Collector Current	V_{CE} = 1200 V, V_{GE} = 0 T_J=25 ℃ T_J=175 ℃	- -	- 1000	50 -	μA
I_{GES}	Gate Leakage Current	V_{GE} = ±25 V, V_{CE} = 0 V	-	-	±100	nA
$V_{GE(th)}$	Gate-Emitter Threshold Voltage	V_{CE} = V_{GE} , I_C = 250 μA	4.9	5.7	6.5	V
$V_{CE(SAT)}$	Collector-Emitter Saturation Voltage	V_{GE} = 15 V, I_C = 20 A, T_J=25 ℃ T_J=150 ℃	- -	1.18 1.23	- -	V
		V_{GE} = 15 V, I_C = 40 A, T_J=25 ℃ T_J=150 ℃ T_J=175 ℃	- -	1.45 1.59 1.61	1.80 - -	
V_{FEC}	Diode Forward Voltage	V_{GE} = 0 V, I_F = 20 A, T_J =25 ℃ T_J =150 ℃	- -	1.75 1.78	- -	V
		V_{GE} = 0 V, I_F = 40 A, T_J =25 ℃ T_J =150 ℃	- -	2.15 2.37	2.40 -	
g_{fs}	Transconductance	V_{CE} = 30 V, I_C = 40 A	-	30	-	S
Dynamic Characteristics						
C_{ies}	Input Capacitance	V_{CE} = 30 V, V_{GE} = 0 V, f = 1.0 MHz	-	5,980	-	pF
C_{oes}	Output Capacitance		-	115	-	pF
C_{res}	Reverse Transfer Capacitance		-	25	-	pF
Q_g	Total Gate Charge	V_{CE} = 960 V, I_C = 40 A, V_{GE} = 15 V	-	178	-	nC
t_{sc}	Short Circuit Withstand Time	V_{CE} = 600 V, V_{GE} = 15 V T_J=100 ℃	10	-	-	μs

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Electrical Characteristics T_J=25°C unless otherwise specified

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
Switching Characteristics						
$t_{d(on)}$	Turn-On Delay Time	V_{CE} = 600 V, I_C = 40 A, R_G = 10 Ω, V_{GE} = 0 / 15 V (Note. 2)	-	81	-	ns
t_r	Turn-On Rise Time		-	26	-	ns
$t_{d(off)}$	Turn-Off Delay Time		-	264	-	ns
t_f	Turn-Off Fall Time		-	38	-	ns
E_{on}	Turn-On Energy Loss		-	2.06	-	mJ
E_{off}	Turn-Off Energy Loss		-	1.81	-	mJ
E_{tot}	Total Energy Loss		-	3.87	-	mJ
$t_{d(on)}$	Turn-On Delay Time	V_{CE} = 600 V, I_C = 40 A, R_G = 10 Ω, V_{GE} = 0 / 15 V T_J = 150 ℃ (Note. 2)	-	84	-	ns
t_r	Turn-On Rise Time		-	30	-	ns
$t_{d(off)}$	Turn-Off Delay Time		-	283	-	ns
t_f	Turn-Off Fall Time		-	76	-	ns
E_{on}	Turn-On Energy Loss		-	2.45	-	mJ
E_{off}	Turn-Off Energy Loss		-	2.56	-	mJ
E_{tot}	Total Energy Loss		-	5.01	-	mJ
Diode Reverse Recovery Characteristics						
t_{rr}	Diode Reverse Recovery Time	V_R = 600 V, I_F = 40 A, di/dt = 1000 A/μs	-	165	-	ns
I_{rr}	Diode Reverse Recovery Current		-	21.6	-	A
Q_{rr}	Diode Reverse Recovery Charge		-	1.80	-	μC
t_{rr}	Diode Reverse Recovery Time	V_R = 600 V, I_F = 40 A, T_J = 150 ℃ di/dt = 1000 A/μs	-	265	-	ns
I_{rr}	Diode Reverse Recovery Current		-	25	-	A
Q_{rr}	Diode Reverse Recovery Charge		-	3.61	-	μC

Notes : 2. Include tail current and diode reverse recovery.

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IGBT Static Characteristics Figure.

Figure.1 Saturation Voltage characteristics ,Junction Temperature(T_J) 25℃

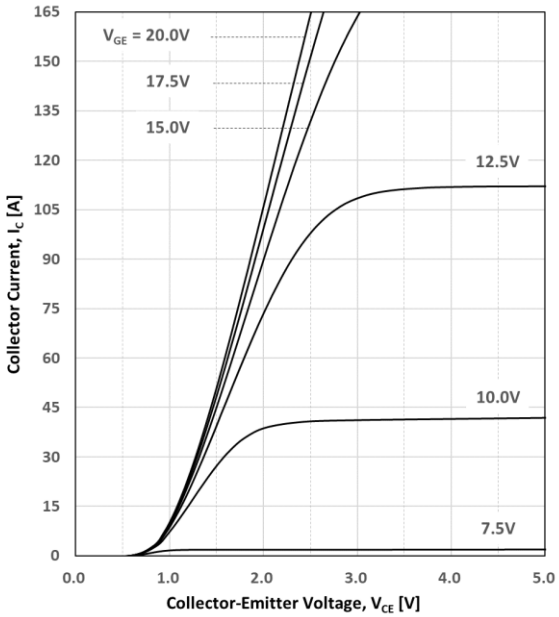


Figure.2 Saturation Voltage characteristics ,Junction Temperature(T_J) 150℃

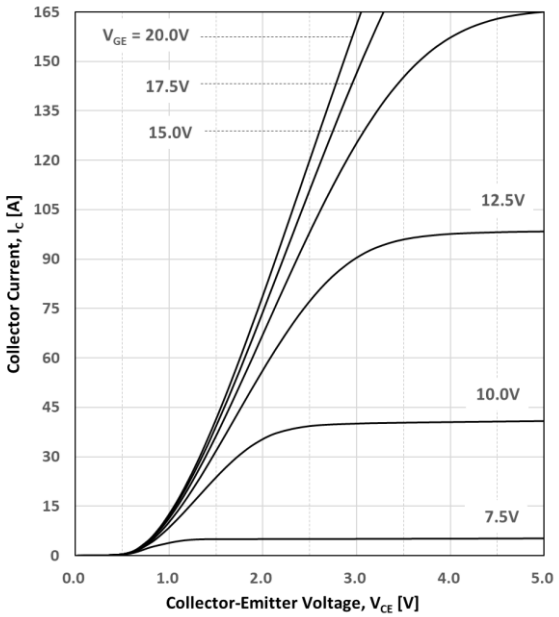


Figure.3 Saturation Voltage characteristics as Junction Temperature, V_{GE}=15V

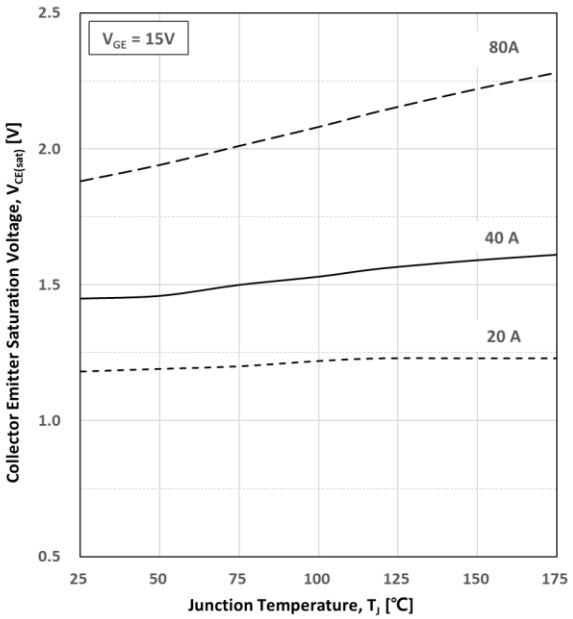
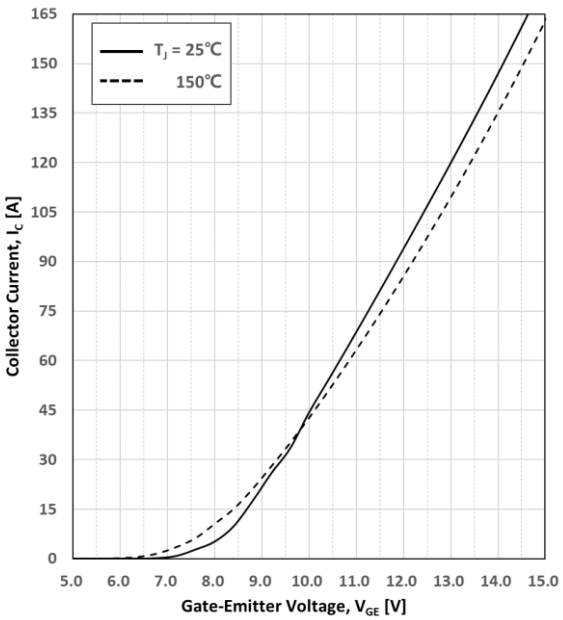


Figure.4 Transconductance characteristics as Junction Temperature



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Figure.5 Threshold Voltage characteristics as Junction Temperature

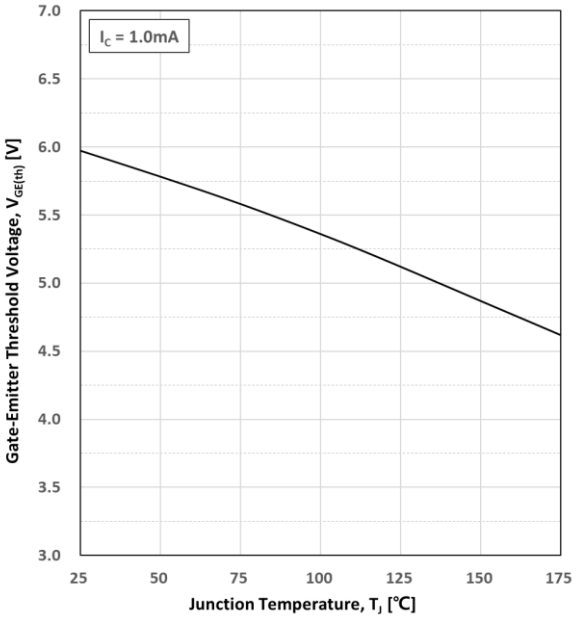
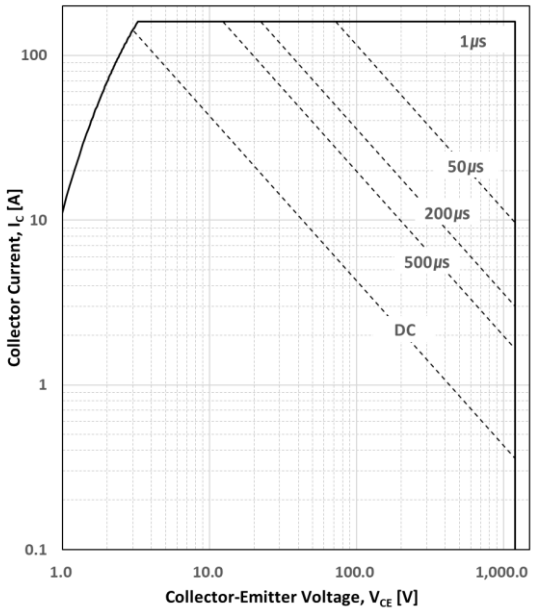


Figure.6 Forward Bias Safe Operating Area (T_C=25℃, T_J≤175℃, V_{GE}=15V, t_p=1μs, D=0)



IGBT Dynamic Characteristics Figure.

Figure.7 Capacitance characteristics (f=1MHz)

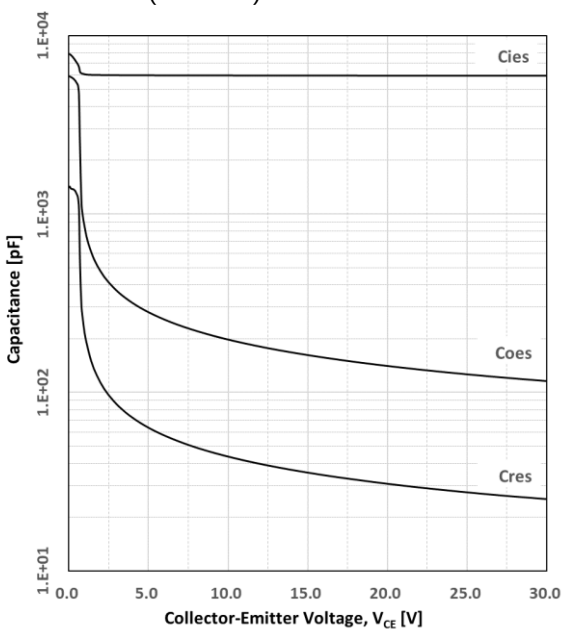
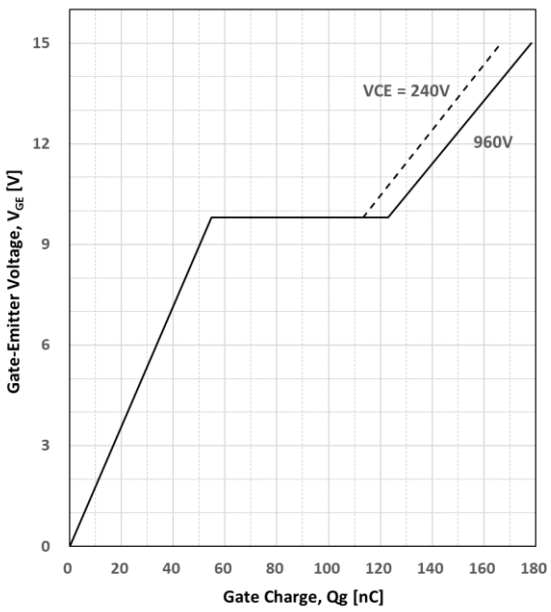


Figure.8 Gate Charge characteristics (I_C=40A)



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IGBT Switching Characteristics Figure.

Figure.9 Switching Times as Gate Resistance
(V_{CE}=600V, I_C=40A, V_{GE}=15V, T_J=25℃)

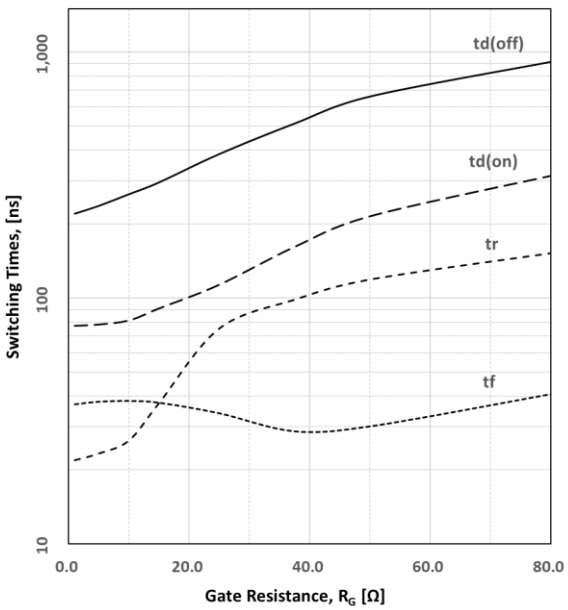


Figure.10 Switching Loss as Gate Resistance
(V_{CE}=600V, I_C=40A, V_{GE}=15V, T_J=25℃)

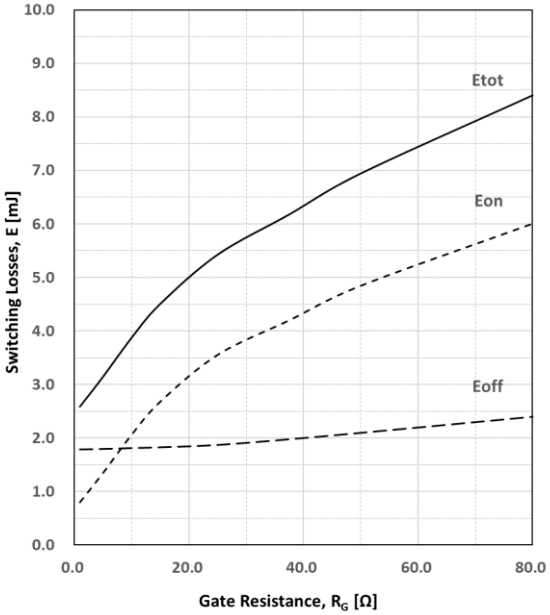


Figure.11 Switching Times as Collector Current
(V_{CE}=600V, V_{GE}=15V, Rg=10Ω, T_J=25℃)

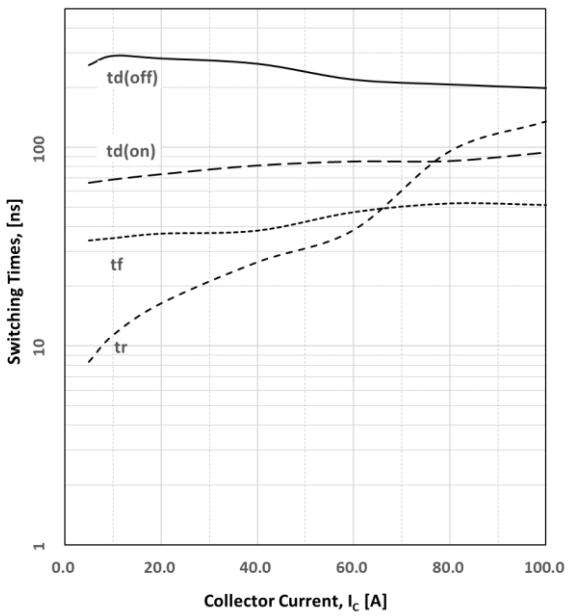
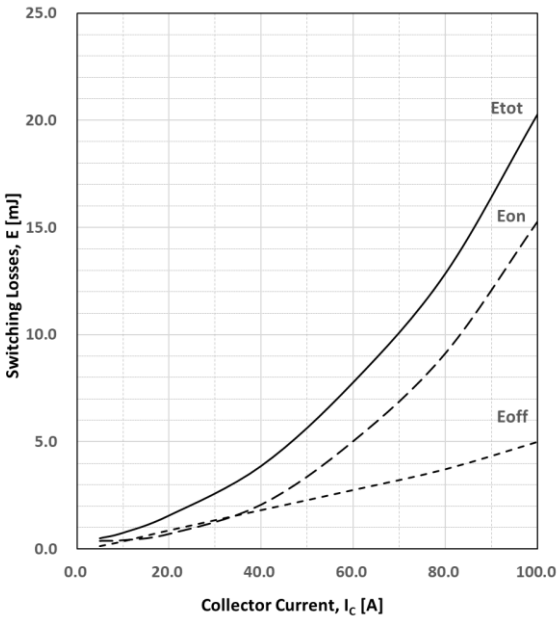


Figure.12 Switching Loss as Collector Current
(V_{CE}=600V, V_{GE}=15V, Rg=10Ω, T_J=25℃)



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Figure.13 Switching Times as Collector Voltage
(I_C=40A, V_{GE}=15V, Rg=10Ω, T_J=25℃)

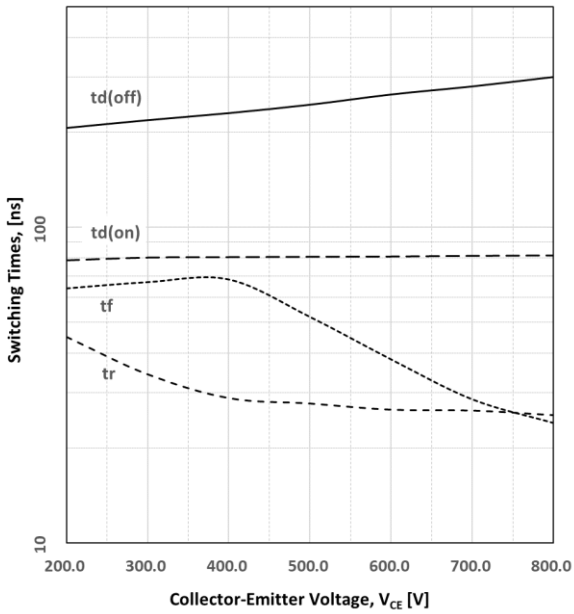


Figure.14 Switching Loss as Collector Voltage
(I_C=40A, V_{GE}=15V, Rg=10Ω, T_J=25℃)

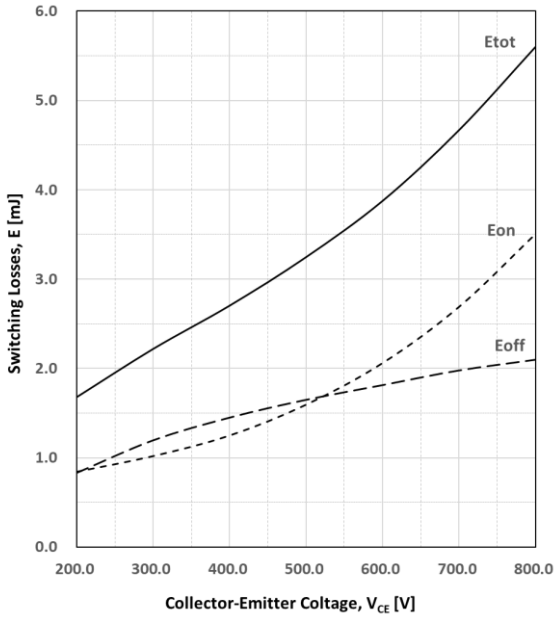


Figure.15 Switching Times as Gate Resistance
(V_{CE}=600V, I_C=40A, V_{GE}=15V, T_J=150℃)

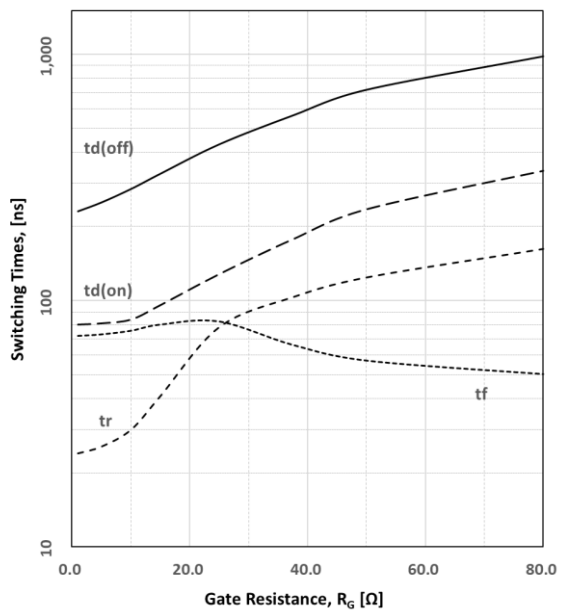
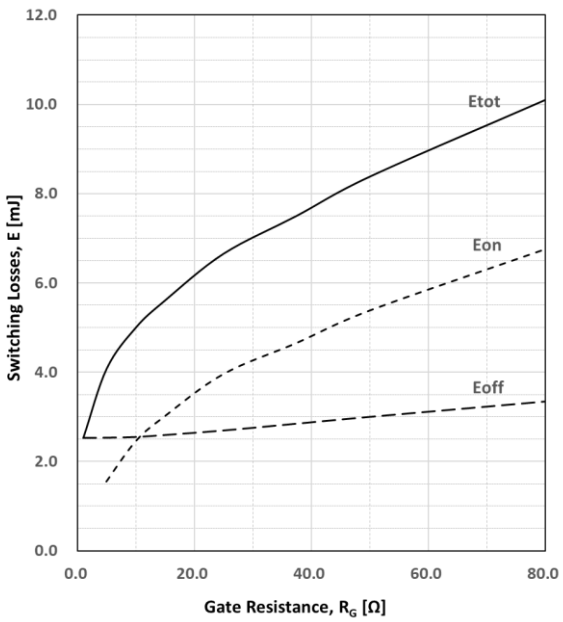


Figure.16 Switching Loss as Gate Resistance
(V_{CE}=600V, I_C=40A, V_{GE}=15V, T_J=150℃)



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Figure.17 Switching Times as Collector Current
(V_{CE}=600V, V_{GE}=15V, Rg=10Ω, T_J=150℃)

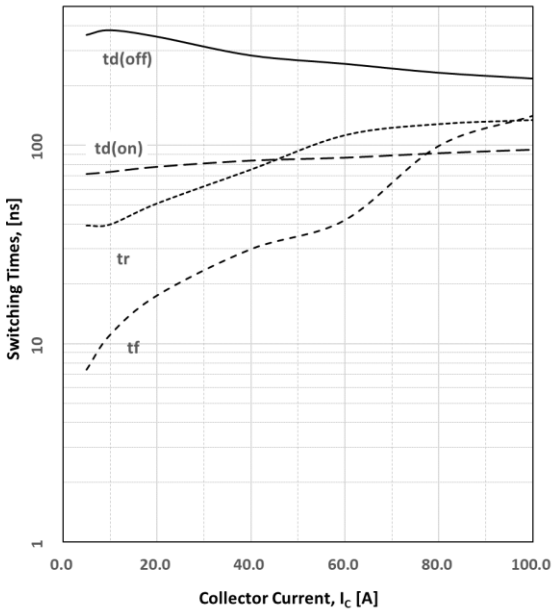


Figure.18 Switching Loss as Collector Current
(V_{CE}=600V, V_{GE}=15V, Rg=10Ω, T_J=150℃)

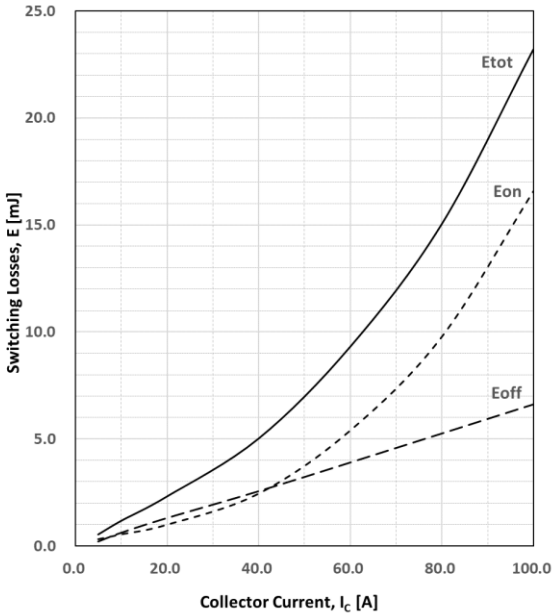


Figure.19 Switching Times as Collector Voltage
(I_C=40A, V_{GE}=15V, Rg=10Ω, T_J=150℃)

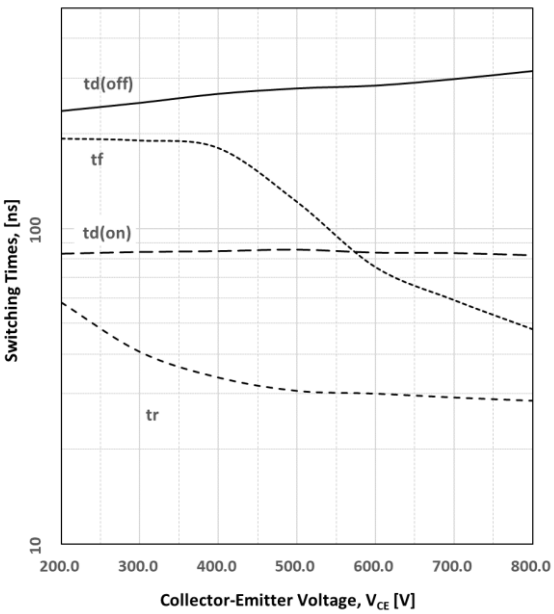
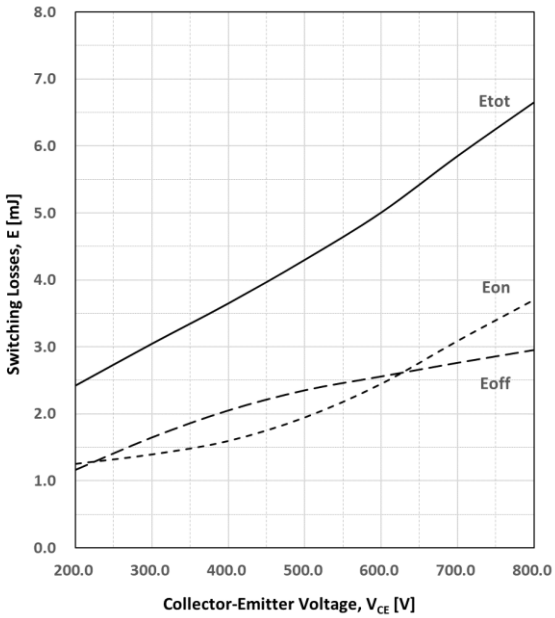


Figure.20 Switching Loss as Collector Voltage
(I_C=40A, V_{GE}=15V, Rg=10Ω, T_J=150℃)



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Figure.21 Switching Times as Junction Temp.
(V_{CE}=600V, I_C=40A, V_{GE}=15V, Rg=10Ω)

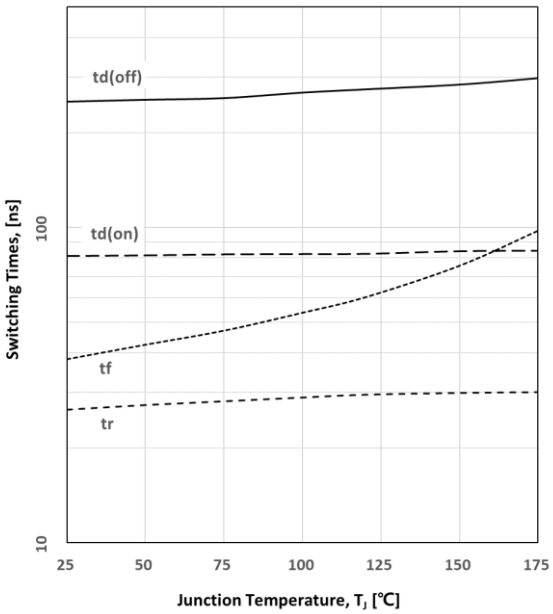
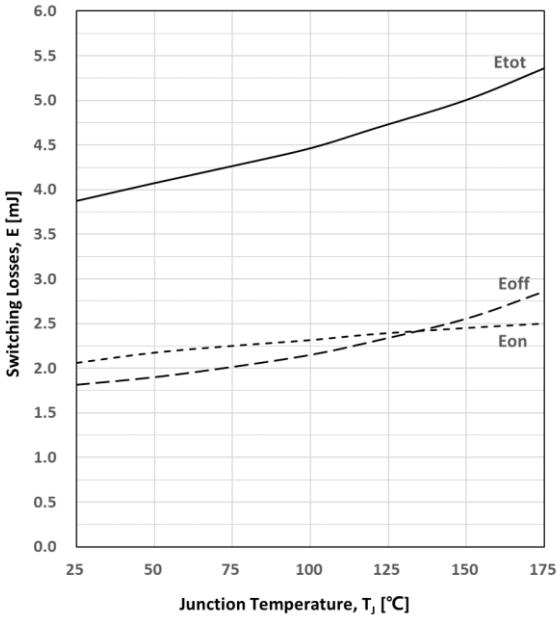
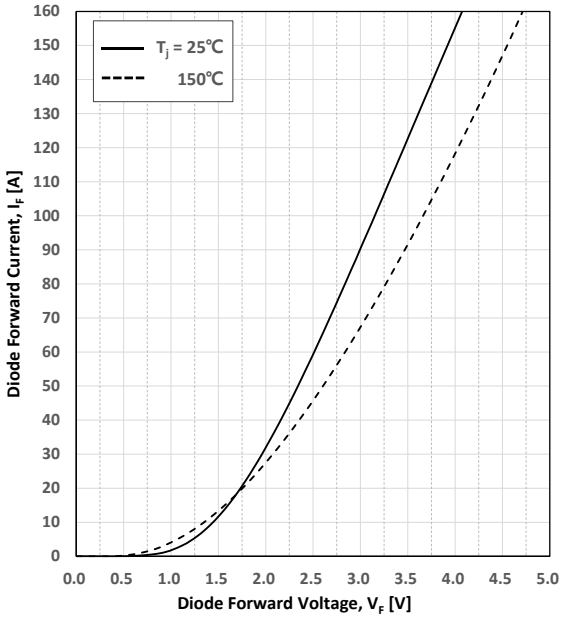


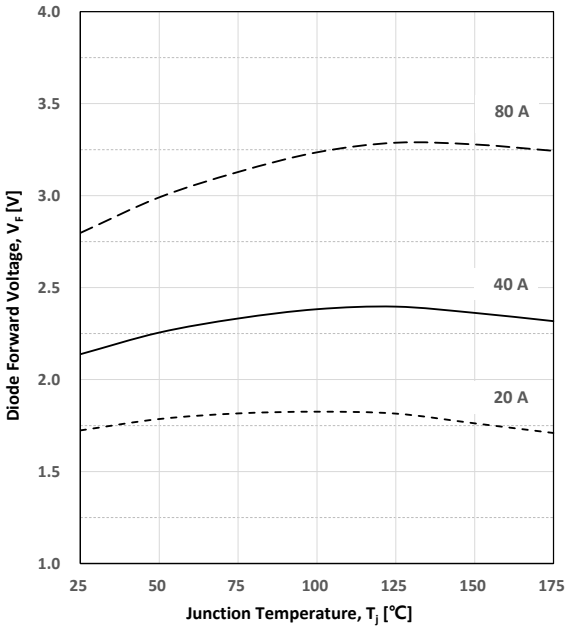
Figure.22 Switching Loss as Junction Temp.
(V_{CE}=600V, I_C=40A, V_{GE}=15V, Rg=10Ω)



Diode Static Characteristics Figure.

Figure.23 Diode Forward current characteristics as Junction Temperature and Forward current





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Diode Reverse Recovery Characteristics Figure.

Figure.24 Reverse Recovery Current as di/dt (V_R=600V, I_F=40A)

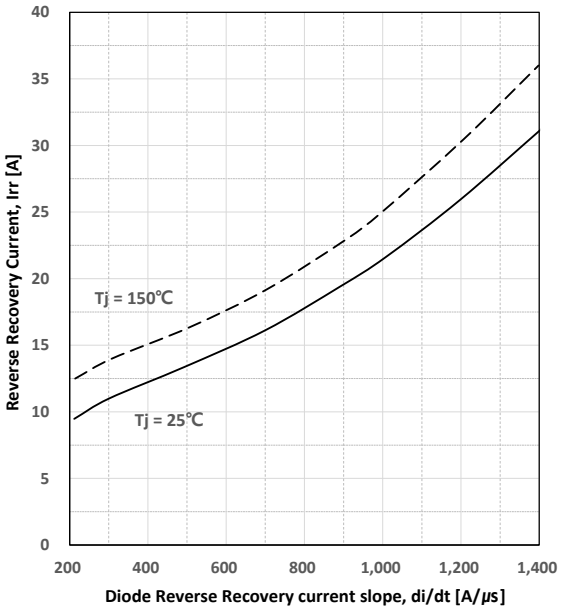


Figure.25 Reverse Recovery Time as di/dt (V_R=600V, I_F=40A)

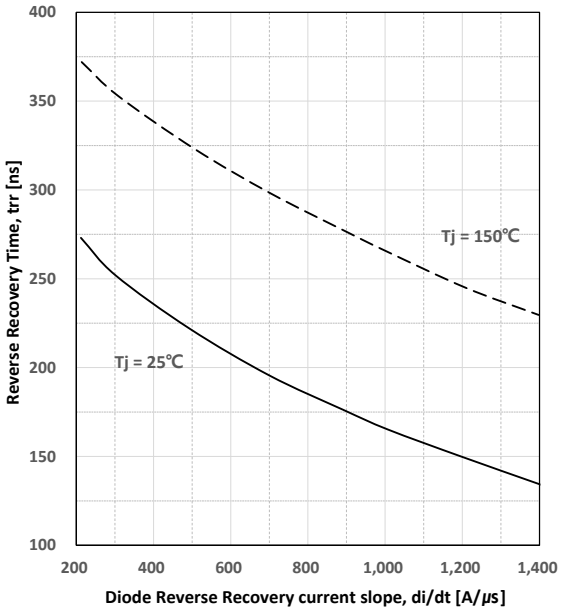
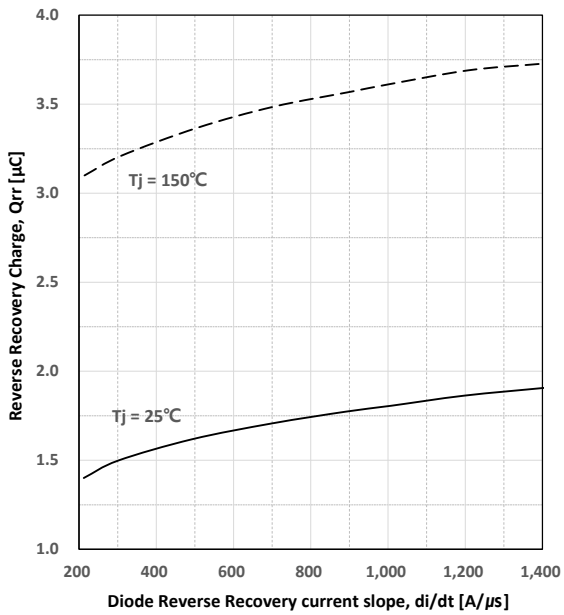
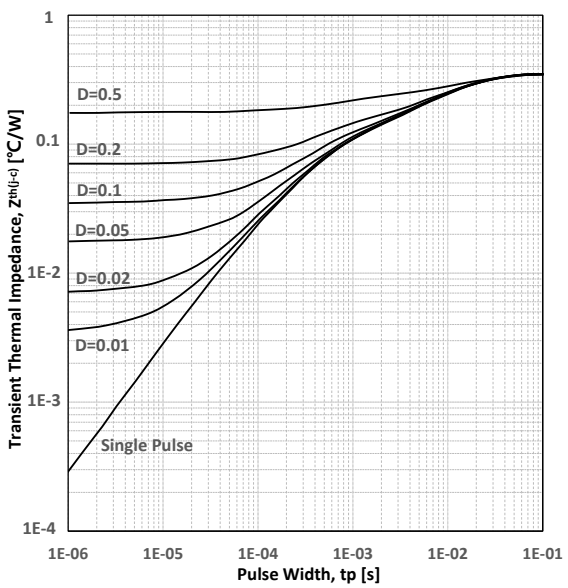


Figure.26 Reverse Recovery Charge as di/dt (V_R=600V, I_F=40A)



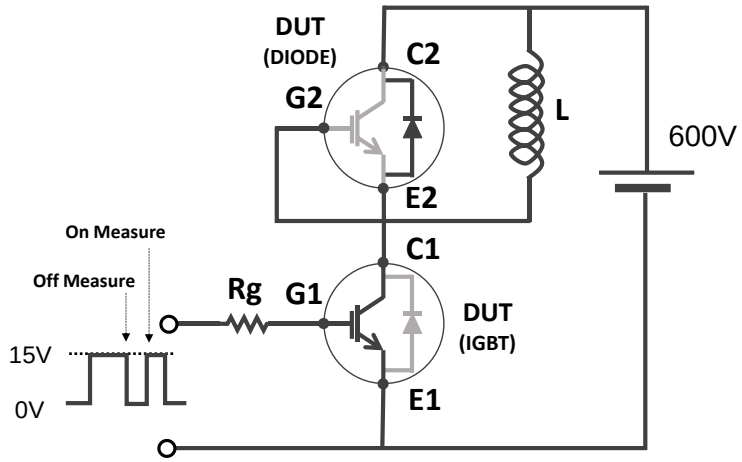
Transient Thermal Impedance Figure.

Figure.27 IGBT Transient Thermal Impedance

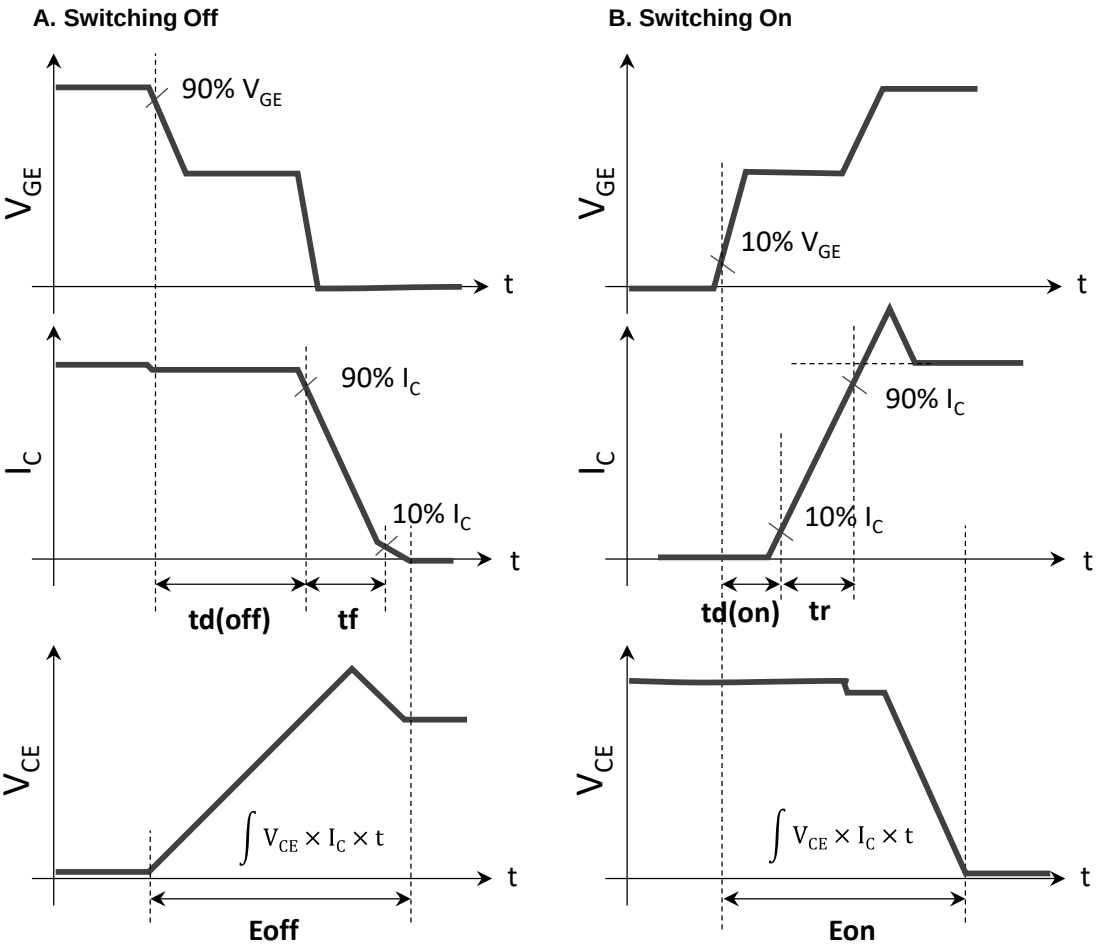


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Ref. 1) Switching Test Circuit

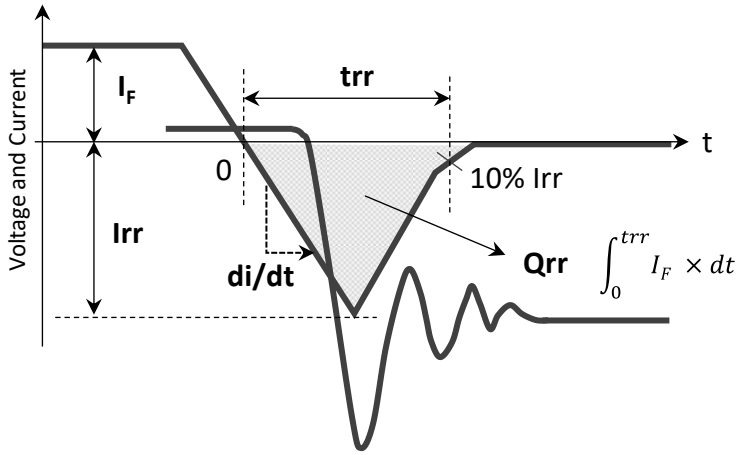


Ref. 2) Definition of switching time and loss

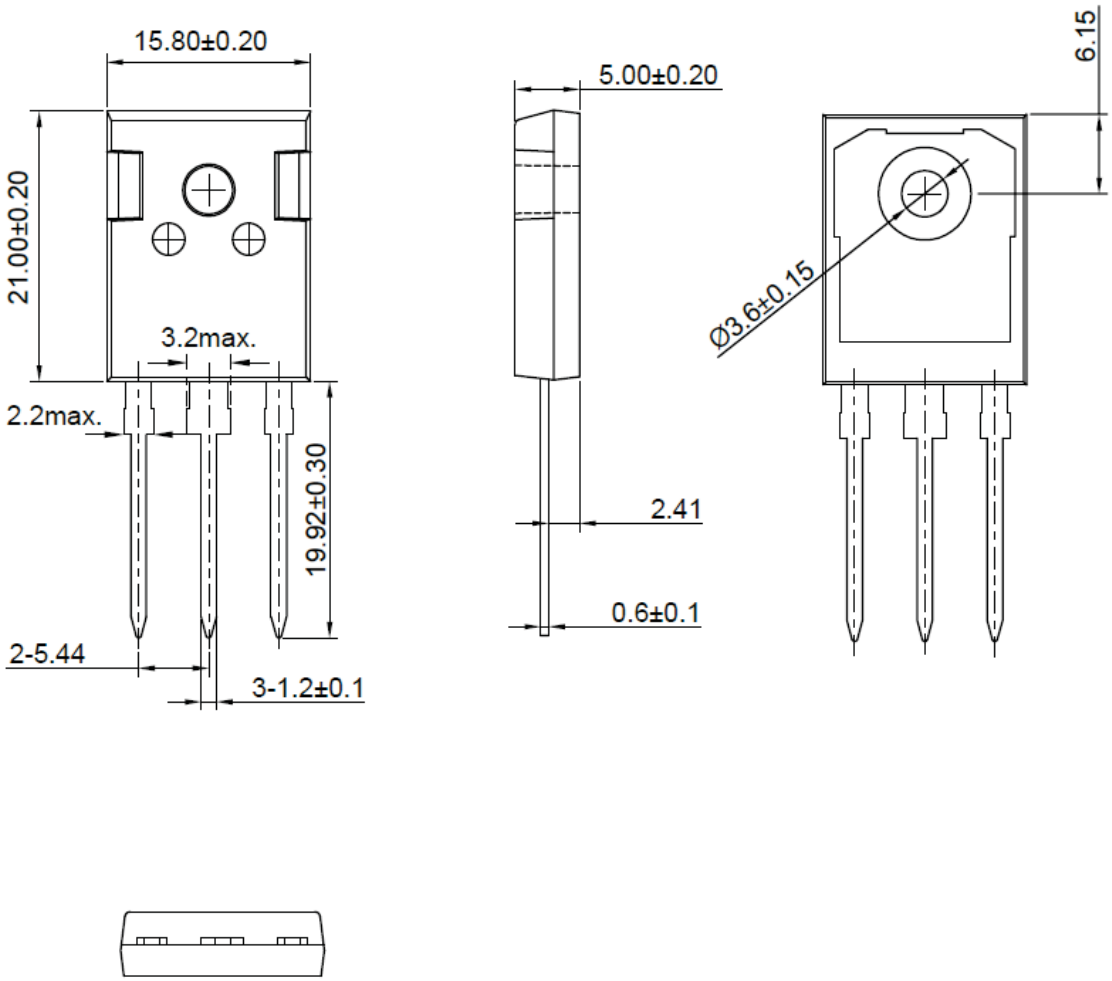


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Ref. 3) Definition of Diode switching time



Package Dimension : TO-247



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